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Case Study: Using Contemporary Behaviour Change Science to Design and Implement an Effective Nutritional Intervention within Professional Rugby League

Running Head: 'Using Behaviour Change Science Within a Nutritional Intervention'

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Abstract

Designing and implementing successful dietary intervention is integral to the role of sport nutrition professionals as they attempt to positively change the dietary behaviours of athletes. High-performance sport is a time-pressured environment where immediate results can often supersede pursuit of the most effective evidence-based practice. However, efficacious dietary intervention necessitates comprehensive, systematic and theoretical behavioural design and implementation if the habitual dietary behaviours of athletes are to be positively changed. Therefore, this case study demonstrates how the Behaviour Change Wheel was used to design and implement an effective nutritional intervention within professional rugby league. The eight-step intervention targeted athlete consumption of a high quality dietary intake of 25.1 MJ each day, to achieve an overall body mass increase of 5 kg across a twelve-week intervention period. The Capability, Opportunity, Motivation-Behaviour model and APEASE criteria were used to identify population-specific intervention functions, policy categories, behaviour change techniques and modes of intervention delivery. The resulting intervention was successful, increasing the average daily energy intake of the athlete to 24.5 MJ, which corresponded in a 6.2 kg body mass gain. Despite consuming 0.6 MJ less per day than targeted, secondary outcome measures of diet quality, strength, body composition and immune function all substantially improved, supporting a sufficient energy intake and the overall efficacy of a behavioural approach. Ultimately, the Behaviour Change Wheel provides sport nutrition professionals with an effective and practical step-wise method via which to design and implement effective nutritional interventions for use within high-performance sport.

Keywords: Behaviour Change Wheel, Nutrition, Sports Nutrition

Introduction

Designing and implementing successful dietary intervention is integral to the role of sport nutrition professionals as they attempt to positively change the dietary behaviours of athletes. High-performance sport is a time-pressured environment where necessity for immediate results can often supersede pursuit of the most effective evidence-based practice (Coutts, 2017). This is apparent within contemporary dietary intervention, which lacks comprehensive, theoretical or systematic behavioural design and implementation (Atkins & Michie, 2015). Instead, current dietary approaches within high performance sport are based upon fast, implicit, common sense models (Michie et al., 2009), consistently shown to result in less effective intervention (Craig et al., 2008). Evidently, novel approaches are required that provide both the scientific rigour and ease of application required for nutritional interventions to be successful within the challenging environment of professional sport (Jones et al., 2017).

The purpose of this case study was to demonstrate how the Behaviour Change Wheel (BCW; Michie et al., 2014) was used to design and implement a successful nutritional intervention aimed at increasing the BM of a professional male adolescent rugby league (RL) player, herein referred to as "the athlete".

The Athlete

The athlete was an eighteen-year-old professional male adolescent RL positional centre, who had recently signed a senior contract with a European Super League club. He was required to increase his body mass (BM) to 90 kg before joining the first team squad. This required a 5.6 kg increase over a twelve-week intervention period. The athlete was susceptible to illness and had missed a combined total of 22 training days over the last five months. Previous nutritional interventions had failed to result in substantial BM gains. Written informed consent was provided and ethics approval granted by Leeds Beckett University, UK.

Athlete Assessment

Anthropometric and Strength Assessment

Anthropometric and strength characteristics were assessed at baseline and at the end of the twelve-week intervention period. Changes in body composition were assessed by dual-energy X-ray absorptiometry scans (DXA, Lunar iDXA, GE Medical Systems, UK) and sum of eight skinfold assessments following standard procedures (Jones et al., 2017). Strength was assessed via three-repetition maximums (3-RMs) as previously reported (Cronin & Hansen, 2005). Pre-and post-intervention values are presented in Table 1.

Dietary Assessment

Dietary intake was measured at baseline and at the end of the twelve-week intervention period via Snap-N-Send, a valid and reliable dietary assessment tool (Costello et al., 2017a; Costello et al., 2017b). The four-day assessment period included two weekdays and two weekend days (Friday-Monday). Data were analysed using dietary analysis software (Nutritics, Version 3.06, Dublin, Ireland). Pre- and post-intervention dietary intakes are presented in Table 2 and Appendix 1.

Total Energy Expenditure Assessment

Resting metabolic rate (RMR) was assessed using an on-line gas analyser (Metalyzer 3BR3, Cortex, Leipzig, Germany) one day prior to the start of the total energy expenditure (TEE) assessment, as outlined by Compher et al. (2006). TEE was assessed over a two-week pre-season period via doubly labelled water (DLW), the literature gold standard (Westerterp, 2017). The assessment period included ten training and four rest days. Measured RMR was 14.7 MJ and average TEE was 22.4 MJ.day^{-1} across the two-week period. Average TEE was 24.1 MJ.day^{-1} and 18.3 MJ.day^{-1} on training and rest days, respectively.

INSERT TABLE 1 & 2 HERE

Design and Implementation of the Nutritional Intervention

The Behaviour Change Wheel is a practical eight-step theory of behaviour change (Michie et al., 2014). The core of the wheel incorporates a model of behaviour known as the COM-B (Michie et al., 2011), which identifies the sources of behaviour that are important for intervention. It states that an individual requires Capability (C), Opportunity (O) and Motivation (M) to perform a Behaviour (B). Surrounding the COM-B are nine intervention functions (Education; Persuasion; Incentivisation; Coercion; Training; Restriction; Environmental Restructuring; Modelling; Enablement) and seven policy categories (Communication/Marketing; Guidelines; Fiscal Measures; Regulation; Legislation; Environmental/Social Planning; Service Provision) (Michie et al., 2014). Further information regarding the nine intervention functions and seven policy categories can be found in Michie et al. (2014).

Step 1: Define the Outcome in Behavioural Terms – The first step of the BCW involves describing the intervention outcome behaviourally. As such, the outcome cannot be for the athlete to gain BM, as this is not a behaviour. Correct application of this first step is essential. To drive successful dietary behaviour change the intervention has to target a behavioural outcome. From baseline data, the athlete consumed 16.7 MJ.day^{-1} and expended 22.4 MJ.day^{-1}. This represented an estimated 5.9 MJ.day^{-1} deficit, supporting observed symptoms characteristic of relative energy deficiency in sport (Mountjoy et al., 2014, 2015). To increase BM by the desired 5.6 kg, the athlete needed to gain 0.5 kg each week and therefore consume a daily energy surplus of approximately 2.1 MJ. Accordingly, a suitably defined behavioural intervention targeted athlete consumption of 25.1 MJ of high quality foodstuffs each day for the following twelve weeks.

Step 2: **Select A Target Behaviour(s)** – Behaviours are part of a dynamic and interactive system, they do not occur in isolation (Atkins & Michie, 2015). Therefore, a long list of all the potential behaviours that may affect the ability of the athlete to consume 25.1 MJ each day was developed, drawing upon relevant literature (Birkenhead & Slater, 2015). This list included detailed input from the athlete and significant others (i.e. parents). The list of potential behaviours was then systematically shortened. Criteria developed by Michie et al. (2014) was used to identify which behaviour(s) to target: Likely Impact, Ease of Implementation, Likely Spillover (i.e. collateral impact) and Ease of Measurement.

Applying these criteria resulted in the following five behaviours being identified;

1. Increase the knowledge of the athlete, and significant others, about the health, development and performance benefits of consuming a high quality dietary intake of 25.1 MJ each day.
2. Increase the knowledge of the athlete, and significant others, about how to achieve a high quality dietary intake of 25.1 MJ each day. This should specify what to eat, in what quantities and at what times.
3. Provide the athlete with free and discounted high-quality food and batch-tested supplements.
4. Regularly assess the BM of the athlete. Progress should be immediately relayed back to the athlete, significant others and head coach.

5. Provide the athlete with regular, immediate and accessible support via the cellular network.

It is imperative practitioners apply appropriate time to consider all population-specific relevant behaviours. Choosing the wrong key target behaviours at this stage will most likely result in an unsuccessful dietary intervention.

Step 3: Specify The Targeted Behaviour(s) – The five identified behaviours were then contextualised in appropriate detail, considering;

- *Who* needs to perform the behaviour?
- *What* does the person need to do differently to achieve the desired change?
- *When* will they do it?
- *Where* will they do it?

This specification is provided in Table 3.

INSERT TABLE 3 HERE

Step 4: Identify What Needs to Change – The COM-B model was used to identify what needed to change to ensure the behaviour(s) occurred. Specifically, did the athlete have both the *physical* and *psychological* Capability, *physical* (i.e. environmental) and *social* (i.e. cultural) Opportunity and finally, the *reflective* (i.e. evaluations and plans) and *automatic* (i.e. emotions and impulses) Motivation to consume a high quality dietary intake of 25.1 $MJ.day^{-1}$. Each of these constructs were satisfied to ensure the overall behavioural outcome was successfully achieved (Michie et al., 2014).

The COM-B behavioural analysis is identified in Table 3. All targeted behaviours performed by the sport nutrition professional (1, 2, 4 & 5) were hindered by *physical* Opportunity (i.e. environmental restrictions). Like all competent practitioners, the nutritionist had both the Capability and Motivation to perform the behaviours but was limited in his Opportunity to deliver them. Whereas the club (3), was hindered in their *reflective* Motivation (i.e. evaluations and plans), not Capability or Opportunity, to provide an academy player with first team free food or supplement privileges. Finally, the athlete (4) was hindered by his *physical* Capability (i.e. not owning weighing scales) and *automatic* Motivation to consume 25.1 $MJ.day^{-1}$ of high quality food stuffs.

Step 5: Identify Intervention Functions - Having made a behavioural diagnosis via the COM-B, the next step was to build the intervention. Intervention functions are broad categories of means by which an intervention can change behaviour. The APEASE criteria has been developed to support function selection (Michie et al., 2014);

1. Is it **A**ffordable?
2. Is it **P**ractical?
3. Will it be **E**ffective/Cost-Effective?
4. Is it **A**cceptable?
5. Is it **S**afe?
6. Does it have **E**quity? (APEASE)

The intervention function ‘coercion’ (i.e. create expectation of punishment) was chosen to intervene on the *physical* Opportunity of the sport nutrition professional and *reflective* Motivation of the club. For example, the athlete received sanction if he did not attend organised nutrition sessions, whereas, it negatively impacted the club to not provide the athlete with the resources necessary for optimal development. The intervention functions ‘environmental restructuring’ (i.e. provide a weighing scale) and ‘enablement’ (i.e. provide free high quality food stuffs) were chosen to increase the *physical* Capability and *automatic* Motivation of the athlete, respectively.

Step 6: Identify Policy Categories - Seven policy categories sit on the outer layer of the BCW (Michie et al., 2014). Policies identify how specified intervention functions will be delivered. For example, the intervention function ‘enablement’ was appropriately delivered via ‘regulation’ (i.e. establishing rules to ensure the athlete remembered to report their fasted BM bi-weekly). The intervention functions ‘environmental restructuring’ and ‘coercion’ were delivered via ‘regulation’ and ‘legislation’, respectively.

Step 7: Identify Behaviour Change Techniques – Behaviour change techniques (BCTs) are the ‘active ingredients’ within an intervention, designed to bring about the desired behavioural change (Michie et al., 2014). There are 93 consensually agreed BCTs (Michie et al., 2011), which were systematically chosen in response to identified intervention functions and contextualised via the APEASE criteria. Examples utilised within this nutritional intervention include, ‘goal setting’ (i.e. to consume six meals consistently each day) and ‘self-monitoring of behaviour’ (i.e. self-reported fasted BM assessments).

Step 8: Identify Mode of Delivery - The final stage of the BCW involves identifying how each aspect of the intervention will be implemented. All available options were contextualised and systematically selected via the APEASE criteria. This intervention utilised group and individual face-to-face delivery (i.e. coercion via legislation – contractual agreement between the club and significant others outlining the requirement for the athlete to attend all nutrition sessions) and group and individual cellular contact (i.e. enablement via regulation – the athlete must respond to WhatsApp reminders from the sport nutrition professional when completing his self-reported BM assessment).

Outcome of the Intervention

The athlete increased his BM by 6.2 kg across the twelve-week intervention, exceeding the targeted 5 kg gain by 24%. As such, the intervention was deemed successful. BM changes consisted of a 4.8 kg and 1.6 kg increase in FFM and fat mass, respectively, representing only a 0.2 % increase in body fat. Such changes evidence the quality of dietary intake (Appendix 1), which included a reduction in average alcohol and free-sugar intakes by 18g and 120g per day, respectively. The athlete reported no symptoms of gastro-intestinal discomfort throughout the assessment period. Nutritional improvements occurred in conjunction with a notable 305 N improvement in the mid-thigh pull, a surrogate measure of absolute strength (McGuigan & Winchester, 2008). Finally, the athlete also reported no symptoms of illness across the intervention period, attending all 61 training sessions. Collectively, these results suggest that the average 24.5 MJ daily energy intake of the athlete, although 0.6 MJ less than targeted, was sufficient to meet energy availability demands (Mountjoy et al., 2014, 2015).

Conclusion and Practical Considerations

Delivering successful dietary intervention is integral to the role of sport nutrition professionals. The BCW represents an easy and practical way to design and implement more efficacious dietary intervention within high-performance sport (Atkins & Michie, 2015). Despite this, athletes are individuals and will behave uniquely in response to intra-personal, inter-personal and external factors (Ogden, 2016).

Therefore, practitioners are encouraged to perform deliberate practise before real-life application, taking advantage of the considerable resources available to guide more successful implementation.

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Table 1. Anthropometric and Strength Assessment Pre-and Post-Intervention

Athlete Characteristic	**Baseline**	**Post-Intervention**	**Percent Change (%)**
Body mass (kg)	84.6	90.8	7.3
Lean-tissue mass (kg)	64.3	69.0	7.3
Bone mineral content (kg)	3.2	3.3	3.1
Fat mass (kg)	17.1	18.5	8.2
Body Fat Percentage (%)	20.2	20.4	1
ISAK sum of eight skinfolds (mm)	83	90	8.4
Strength Assessment (3RM)	**Baseline**	**Post-Intervention**	**Percent Change (%)**
Bench press (kg)	112.5	120	6.7
Prone row (kg)	86.5	92.5	6.9
Military press (kg)	60	65	8.3
Back squat (kg)	125	135	8.0
Mid-thigh pull (N)	3,242	3,547	9.4

Table 2. Average Daily Dietary Intake Pre-and Post-Intervention

Average Dietary Intake	**Baseline**	**Post-Intervention**	**Percent Change (%)**
Carbohydrate (g)	440	645	46.6
Free sugar (g)	178	58	-67.4
Fat (g)	142	213	50.0
Saturated (g)	42	84	100.0
Protein (g)	142	331	133.1
Alcohol (g)	18	0	-100
Total Energy Intake (MJ)	16.7	24.5	46.7

Table 3. Specification of the Target Behaviours and COM-B Behavioural Analysis

Target Behaviour	*Who*	*What*	*When*	*Where*	**COM-B Behavioural Analysis**
1. Increase the knowledge of the athlete, and significant others, about the health, development and performance benefits of consuming a high quality dietary intake of 25.1 MJ (6,000 kcal) each day.	sport and exercise nutritionist	Oral presentation / written information / infographics / other support as required	Start of twelve-week intervention / as required throughout	Club / appropriate social media platforms for athlete (i.e. WhatsApp), and significant others (i.e. google drive, text, email)	*Physical* Opportunity – Sport and Exercise Nutritionist
2. Increase the knowledge of the athlete, and significant others, about how to achieve a high quality dietary intake of 25.1 MJ (6,000 kcal) each day. This should specify what to eat, in what quantities and at what times.	sport and exercise nutritionist	Oral presentation / written information i.e. diet plan(s) & guide(s) / shopping list(s) / infographics / accessible recipes / other support as required	Start of twelve-week intervention / as required throughout	Club / appropriate social media platforms for athlete (i.e. WhatsApp), and significant others (i.e. google drive, text, email)	*Physical* Opportunity – Sport and Exercise Nutritionist
3. Provide the athlete with free and discounted high-quality food and batch-tested supplements, as available to first team athletes.	Club	Free batch tested supplements i.e. whey protein, creatine, mass gainer / free meals around training and competition i.e. breakfast, pre-& post-game meals or snacks / snacks available at 'food station' / cost price meat bundles delivered to house / discount on sponsored products i.e. biltong	Start of twelve-week intervention / as required throughout	Club / home (delivered)	*Reflective* Motivation – Club
4. Regularly assess the BM of the athlete. Progress should be immediately relayed back to him, significant others and the head coach.	Athlete & sport and exercise nutritionist	Bi-weekly fasted weigh-in (self-reported by athlete) / weekly sum of 8 skinfolds (Sport and Exercise Nutritionist)/ feedback results (Sport and Exercise Nutritionist)	Monday & Thursday mornings (weigh-in) / Monday mornings (skinfolds)	Club / appropriate social media platforms for athlete (i.e. WhatsApp), and significant others (i.e. google drive, text, email)	*Physical* Capability & *Automatic* Motivation – Athlete *Physical* Opportunity – Sport and Exercise Nutritionist

5. Provide the athlete with regular, immediate and accessible support via the cellular network.	sport and exercise nutritionist	Information, advice, knowledge / prompts, cues, nudges / feedback, encouragement / other support as required	As required throughout	Club / appropriate social media platforms for athlete (i.e. WhatsApp), and significant others (i.e. google drive, text, email)	*Physical* Opportunity – Sport and Exercise Nutritionist

Baseline Dietary Intake.

Baseline – Week Day

Food or Drink	Portion	Time of Intake
Weetabix	80g (x4)	07:00
Skimmed Milk	270ml	
Tea (skimmed milk and x1 teaspoon sugar)	260ml	
Crisps	45g (x1)	10:15
Club Penguin	35g (x1)	
Apple	152g	
Lucozade	380ml	
Lasagne	290g	13:30
Oven Chips	180g	
Tomato Ketchup	24g	
Coke	330ml (x1 can)	
Tea (skimmed milk and x1 teaspoon sugar)	260ml	15:00
Digestive Chocolate Biscuits	64g (x4)	
Powerade	500ml	During Training
Chicken Breast	100g (x1 small breast)	20:30
Sweet Potato Fries	120g	
Orange Juice	300ml	
Galaxy Chocolate Bar	42g	
Cheerio's	35g	11:30
Skimmed Milk	135ml	
Tea (skimmed milk and x1 teaspoon sugar)	260ml	
Digestive Chocolate Biscuits	80g (x5)	

Daily Dietary Intake		
Carbohydrate	(g)	**519**
Free sugar	(g)	**200**
Fat	(g)	**136**
Saturated	(g)	**51**
Protein	(g)	**159**
Alcohol	(MJ)	**0**
Total Energy Intake	(MJ)	**16.8**

Baseline – Weekend Day

Food or Drink	Portion	Time of Intake
Fried Egg	120g (x2)	10:45
Pork Sausage	110 (x2)	
Fried Tomato	50 (x3 slices)	
Hash Brown	80g	
Toast (Brown)	64g	
Butter	10g	
BBQ Sauce	24g	
Tea (skimmed milk and x1 teaspoon sugar)	260ml	
Orange Juice from Concentrate	250ml	14:00
Banana	100g	
Nandos Chicken - Medium	½ Chicken	18:00
Peri Peri Chips	Regular (x2)	
Mayonnaise	24g	
Fanta	285g	
Cider Bottle	1320ml (x4)	21:00
Heineken Bottle	1650ml (x5)	

Daily Dietary Intake		
Carbohydrate	(g)	**324**
Free sugar	(g)	**151**
Fat	(g)	**159**
Saturated	(g)	**35**
Protein	(g)	**147**
Alcohol	(MJ)	**3.8**
Total Energy Intake	(MJ)	**17**

Week 12 Dietary Intake.

Week 12 - Week Day

Food or Drink	Portion	Time of Intake
Protein Weetabix	100g (x6)	07:15
Full Fat Milk	300ml	
Mixed Nuts & Raisins	40g	
Banana	100g	
Arla Quark Yogurt	200g	
Fresh Orange Juice	250ml	
Fish Oil Capsule*	2g (x2)	
Tuna Melt with Salad	250g	10:15
Biltong	40g (x1)	
Large Orange	160g	
Club Penguin	35g (x1)	
Crisps	45g (x1)	
Oasis Summer Fruits	500ml	
Chewing Gum	3g (x1)	11:15
Roast Beef	150g	13:00
Roast Potatoes	190g	
Carrot	85g	
Cauliflower	80g	
Gravy	50g	
Full Fat Milk	300ml	
Soreen Malt Loaf	60g	Pre-Training
Powerade	500ml	During Training
Mass Gainer*	150g (x3 Scoops)	Post-Training
Creatine*	5g	
Full Fat Milk	568ml	
Lamb Chomps	160g	20:00
Mash Potato	250g	
Runner Beans	65g	
Swede	60g	
Gravy	50g	
Full Fat Milk	300ml	
Chocolate Mousse	70g	
Strawberries	65g	
Fage Greek Yogurt	150g	22:15
Honey	20g	
Oats	40g	
Frozen Berries	60g	
Banana	100g	
Nutella	30g	
Full Fat Milk	200ml	
Daily Dietary Intake		
Carbohydrate (g)	**674**	
Free Sugar (g)	**65**	
Fat (g)	**202**	
Saturated (g)	**79**	
Protein (g)	**352**	
Alcohol (MJ)	**0**	
Total Energy Intake (MJ)	**24.7**	

Week 12 - Weekend Day

Food or Drink	Portion	Time of Intake
Scrambled Egg	180g	09:45
Heinz Beans	175g	
Bacon	105g (x3)	
Mushrooms	80g	
Fried Tomato	50g (x3 slices)	
Toast (White)	60g (x2)	
Butter	10g	
Full Fat Milk	300ml	
Fish Oil Capsule*	2g (x2)	
BLT	165g	11:30
Weetabix On The Go Protein	275ml	
Crisps	45g	
Banana	100g	
Kit Kat	22g (x1)	
Subway Foot Long - Meatball Marina	300g	13:00
Tropicana Orange Juice	330ml	
Pear	160g	
Arla Quark Yogurt	200g	
Seeds	14g	
Mixed Berries	40g	
Oasis	500ml	
Salmon Fillet (x2)	210g	20:00
Uncle Ben Microwave Rice	100g	
Asparagus	90g	
Mixed Vegetables	80g	
Full Fat Milk	300ml	
White Magnum	90g	20:30
Fage Greek Yogurt	150g	23:00
Honey	20g	
Kiwi	60g	
Banana	100g	
Peanut Butter	45g	
Full Fat Milk	200ml	
Creatine*	5g	
Daily Dietary Intake		
Carbohydrate (g)	**466**	
Free Sugar (g)	**54**	
Fat (g)	**268**	
Saturated (g)	**104**	
Protein (g)	**264**	
Alcohol (MJ)	**0**	
Total Energy Intake (MJ)	**22.2**	